RESEARCH REPORT and IMPLEMENTATION

STAP Number	Contract Number	Performance Period
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Title

Socio-Economic Effect of Seismic Retrofit Implemented on Bridge in Los Angeles Highway Network

Report Date, No., & Title

October , 2005, F/CA/SD-2005/03, Socio-Economic Effect of Seismic Retrofit Implemented on Bridge in Los Angeles Highway Network

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Abstract

This research studied the socio-economic effect of the seismic retrofit implemented on bridges in Los Angeles Highway Network. Firstly, advanced FE modeling and nonlinear time history analysis are performed to evaluate the seismic performance, expressed in the form of fragility curve, of representative bridges before and after retrofit. Retrofit enhancement ratios are used to measure the improvement of bridges' seismic performance and are applied to empirical fragility curves that are used to simulate damage states of the bridges in the highway network. Secondly, an integrated traffic assignment model that considers the post-earthquake origin-destination, OD, reduction due to building damage, is utilized to evaluate the post-earthquake system performance in terms of daily travel delay and opportunity cost. System recovery is further simulated to obtain the total social cost based on bridge functionality restoration/repair process. Thirdly, the bridge repair cost, social loss and retrofit cost are estimated. The benefit from the retrofit is defined as the avoided social cost and bridge repair cost by comparing the total social and bridge repair cost before and after bridge retrofit. The annualized social loss and bridge repair cost together with the annualized bridge retrofit cost are used for a cost-benefit analysis. The results show that, in either of the two retrofit cases (23% and 100% retrofitted), the retrofit measure is cost-effective if both the avoid social cost and bridge repair cost are considered, and the avoided bridge repair cost can only compensate a small portion of the initial bridge retrofit cost.

Achievement

A group of fragility curves for 5 typical bridge layout are developed. A GIS based computer program utilized network traffic flow computer application was developed to streamline the over all economic effect from a transportation network with damaged bridges.

Conclusion & Recommendation

The nonlinear time history analysis performed in the 5 representative bridges demonstrates that their seismic performance is significantly improved after column retrofit by steel jacketing. The results demonstrate that the retrofit is more effective in reduction of severe damages (major or collapse) than light damages (minor or moderate).

The total social cost associated with the seismically impaired network was obtained by simulating the system performance over any time points after the earthquake based on a time- and damage-dependent bridge restoration model. The simulation results show that the system performance recovery rates are much higher in the several days after the earthquakes than thereafter. When the bridges are retrofitted, the system recovery period is expected to be shorter and the total social cost, which is estimated by the integration of the daily time cost over the recovery period, is also smaller.

In the cost-benefit analysis for the bridge retrofit strategies, the avoided social loss and bridge repair cost is considered as the benefit, and retrofit expenditure as the cost. The results show that either 23% (Case 2, current status) or 100% (Case 3, all) retrofit is cost-effective. The avoided bridge repair cost is only a small portion of the benefit obtained from the bridge retrofit, and if only reduction in bridge repair cost is considered, either retrofit strategy (Case 2 or Case 3) applied in bridges is not cost-effective. The dominant part of the benefit is provided by the avoided social loss due to the enhanced system resilience resulting from bridge retrofit.

Contract Manager	Technical Support Team
Li-Hong Sheng	N/A

Implementation Recommendations

3/01/2006

Provided information and distributed final report and software to the DRI REDARS team for reference. These two projects had many idea in common but go into different direction in software development. REDARS was original started from a FHWA research subject as extension to HAZUS.

OEE may be able to use the software layout from UCI to develop our own GIS application for Pre-EQ planning, Post-EQ response and future improvement of EQ scenario study.

Implementation Measure Taken

04/12/2006

Suggest DRI to develop a in-house tool to continue the effort and experiences learned from UCI research and REDARS for long term operation. A in-house development can eliminate the limitation posed from REDARS in data update, GUI, and program maintenance. A integrated GIS application will be more useful to internal operation.